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POST-FARROWING HEALTH STATUS OF SOWS AND PIGLETS IS CORRELATED WITH LACTATION OUTCOMES OF SOWS

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SUMMARY

The genetic (rg) and phenotypic (rp) correlations between piglet vitality at birth, traits measured on sows 2 and 5 days post-farrowing and lactation outcomes were estimated using the data from 2 nucleus farms (N=1103). All observations were analysed as traits of the sow. The highest heritabilities (h2) were estimated for functional and un-suckled teats (0.36±0.09 and 0.24±0.09) and for the number of vital piglets (0.09±0.07). Detrimental piglet attributes were genetically and phenotypically associated with each other and with a lower number of weaned piglets. High respiration rate and rectal temperature were genetically (0.81±0.31 and 0.73±0.30), but not phenotypically, associated with the number of weaned piglets. Correlations between other traits were not significantly different from zero, or had high standard errors and therefore required more data for more accurate estimation of variance components.

INTRODUCTION

Examination of sows and piglets shortly after farrowing can be used to identify risk-factors, which might have an impact on lactation outcomes (Madec *et al*. 1992). Lactation outcome can be defined by the number of weaned piglets, lactation length or removal reasons related to poor mothering ability. While numerous studies reported the association between birth weight and the number of weaned piglets, relatively fewer studies have considered the implications of other piglet vitality traits at birth and post-farrowing health indicators of sows for the lactation outcomes. The objective of this study was to estimate the genetic parameters for the health-related post-farrowing predictors and to obtain preliminary estimates of the genetic associations with lactation outcomes.

MATERIALS AND METHODS

The data used in this study were recorded at 2 nucleus farms operated by independent companies, collected between October-December 2017 for Farm A (N=558 sows) and March-June 2018 for Farm B (N=545 sows). Further details were provided in Vargovic *et al.* (2019). After farrowing, but before cross-fostering, sows and their piglets were recorded for a range of characteristics. All observations were treated as traits of the sow. Sows were progeny of 352 sires and 852 dams and the pedigree was extended over 5 generations containing 1,261 sires and 3,274 dams in total. There were 104 commercial sows without pedigree retained in the data.

Characteristics of piglets. The vitality of piglets within the birth litter was assessed within 12 hours of the completion of farrowing. Negative indicators for piglet vitality included the number of pale (NPALE) or thin (NTHIN) piglets, whereas the number of vital piglets (NVITAL) was recorded as the total number of piglets without any detrimental attributes.

Characteristics of sows. Sows were recorded for a range of attributes, on days 2 and 5 post-farrowing. Resting respiration rates (RESP2, RESP5) were recorded as the number of expirations per 30 seconds, expressed per minute. Rectal temperatures (RECT2, RECT5) were recorded ensuring

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the thermometer was in contact with the bowel wall. Mastitis (MAST2, 0/1) was considered to be present (score=1) for sows with a hard and swollen udder. Indicators of suckling load included the count of un-suckled (TEATU2) and functional teats (TEATF2). Feed refusal after farrowing (FRAF) was recorded as the proportion of days observed where less than half the meal was eaten, assessed 3-4 hours after the fixed feed delivery. Sows were observed for FRAF over 2.95±2.80 days on average. Lactation failure (LFAIL) and the number of weaned piglets (NWEAN) were defined as described by Vargovic *et al*. (2019).

Analyses. Data preparation and summary statistics were obtained using R (R Core Team 2018). Estimates of variance components were obtained by fitting a linear mixed animal model using residual maximum likelihood procedures in ASReml (Gilmour *et al*. 2014). Systematic effects fitted for sow traits included parity group (4 levels: parities 1, 2, 3-5 and >5) and the interaction between breed and farm (10 levels). For piglet vitality traits, models included total piglets born fitted as a linear covariate. Estimates for heritabilities were obtained from univariate analyses. Correlations were estimated using a series of bivariate analyses.

RESULTS AND DISCUSSION

Characteristics of the data. Traits that represent piglet vitality (NPALE, NTHIN) and the resulting un-suckled teats (TEATU2) were highly variable between litters (Table 1). However, no detrimental attributes were observed on 77.5% of born alive piglets. This study showed that un-suckled teats can be observed early post-farrowing, which could result in rapid regression (Kim *et al*. 2001). Mastitis was recorded in 15.5% of sows, and 5.49/15.5=35% of these sows also had elevated rectal temperatures. However, farrowing followed by physiological hyperthermia can cause misinterpretation as to whether mastitis is present or not (Friendship *et al*. 2015).

Table 1. Raw data characteristics, estimates of heritability (h^2) with standard errors (SE) and phenotypic variance (σ^2_p) from univariate model, with model R^2

Trait	N	Model effects	Mean (SD)	CV%	$h^2_{(SE)}$	σ^2_p	R^2 (%)
NWEAN	1088	P, BF	9.38 (2.62)	28	0.16 (0.08)	6.65	4.50
LFAIL	1100	P, BF	0.098 (0.30)	303	0.09 (0.08)	0.09	2.31
NVITAL	1072	P, BF, TB	8.83 (2.82)	32	0.09 (0.07)	5.31	33.2
NPALE	1072	P, BF, TB	0.93 (1.59)	171	0.04 (0.06)	2.21	12.0
NTHIN	1072	P, BF, TB	2.70 (2.63)	97	0.08 (0.07)	4.96	28.6
RESP2	1025	P, BF	23.7 (12.3)	52	0.17 (0.09)	145	3.03
RESP5	973	P, BF	28.1 (15.4)	55	0.10 (0.08)	236	11.3
RECT2	1064	P, BF	38.9 (0.51)	1	0.21 (0.09)	0.23	0.62
RECT5	1060	P, BF	38.9 (0.57)	2	0.12 (0.08)	0.24	24.5
MAST2	1059	P, BF	0.155 (0.36)	234	0.05 (0.06)	0.13	3.41
TEATU2	1059	P, BF	1.26 (1.33)	105	0.24 (0.09)	1.73	1.39
TEATF2	1059	P, BF	13.8 (1.17)	9	0.36 (0.09)	1.26	8.18
FRAF	1065	P, BF	0.35 (0.39)	114	0.01 (0.07)	0.14	10.3

Abbreviations: NWEAN: count of weaned piglets; LFAIL: lactation failure (0/1); NVITAL, NPALE, NTHIN: count of vital, pale and thin piglets; RESP2 and RESP5: count of expirations/minute; RECT2 and RECT5: rectal temperature (oC); MAST2: mastitis (0/1); TEATU2 and TEATF2: count of un-suckled and functional teats; FRAF: feed refusal after farrowing; P: parity group; BF: breed:farm; TB: total born piglets

Heritability estimates. After accounting for systematic effects, heritability estimates (h^2) were low (<0.07) for NPALE, MAST2 and FRAF (Table 1). The h^2 for NPALE was similar to that reported by

Tabuaciri *et al*. (2011). The highest h^2 was for TEATF2 (0.36±0.09), consistent with Lundeheim *et al*. (2013). With respect to sow attributes, RECT2 and RESP2 were moderately heritable (0.21±0.09 and 0.17±0.09), and lower than reported by Gourdine *et al*. (2017), averaged across lactation (0.35±0.09 and 0.39±0.13). The h^2 for NWEAN was higher (0.16±0.08) than the mean (h^2=0.07) previously reported by Rothschild *et al*. (1998).

Correlations for piglet attributes. NTHIN and NPALE were positively correlated with each other and negatively with NVITAL (Table 2). Both phenotypic (rp) and genetic (rg) correlations indicated that NVITAL was positively correlated with NWEAN and negatively correlated with LFAIL and TEATU2. Piglet vitality at birth is an important contributor to successful lactation outcomes assessed for sows. Lower rg and rp were estimated between piglet traits (NTHIN, NVITAL, NPALE) and sow health-related traits (RESP2, RESP5, MAST2), suggesting independence of these traits genetically.

Correlations for sow attributes. Rectal temperature and respiration rate were strongly correlated with each other (Table 2), and favourably associated with NWEAN, while attributes measured day 5 were less informative, due to lower h^2 and higher standard errors. Sows with high genetic potential for NWEAN had genetically higher RESP and RECT, suggesting better environmental management may be required for genetically superior sows. Moderate to high rg between MAST2 and NWEAN/LFAIL were favourable, indicating that visual observation of udder for mastitis (even without confirmation by taking rectal temperature) was correlated with the number of weaned piglets. Moderate rg between NWEAN and TEATF2 demonstrated that the number of functional teats post-farrowing was favourably associated with the number of weaned piglets. Large rg (-0.97±0.18) and re (-0.73±0.03) between NWEAN and LFAIL are consistent with the use of NWEAN to define LFAIL phenotypes.

CONCLUSIONS

Results presented in this study demonstrated that piglet vitality contributes to sow lactation performances. Sows which wean more piglets were genetically predisposed to higher rectal temperature and respiration rate. Visually assessed presence of mastitis was genetically associated with the lactation outcomes. Large standard errors in genetic parameters were observed, with further data required to reduce this error.

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Table 2. Estimates of genetic (above diagonal) and below diagonal (1st row) residual and (2nd row) phenotypic correlations with SE in subscript for the traits

	NWEAN	LFAIL	NVITAL	NPALE	NTHIN	RESP2	RESP5	RECT2	RECT5	MAST2	TEATU2	TEATF2	FRAF*
NWEAN		-0.97 $_{(0.18)}$	0.57 $_{(0.45)}$	-0.16 $_{(0.61)}$	-0.35 $_{(0.50)}$	0.81 $_{(0.31)}$	0.03 $_{(0.46)}$	0.73 $_{(0.30)}$	0.55 $_{(0.41)}$	-0.37 $_{(0.62)}$	-0.02 $_{(0.33)}$	0.40 $_{(0.28)}$	
LFAIL	-0.73 $_{(0.03)}$		-0.62 $_{(0.57)}$	0.40 $_{(0.78)}$	0.28 $_{(0.63)}$	-0.56 $_{(0.49)}$	0.74 $_{(0.57)}$	-0.94 $_{(0.48)}$	-0.49 $_{(0.53)}$	0.91 $_{(0.74)}$	0.07 $_{(0.41)}$	-0.36 $_{(0.37)}$	
	-0.75 $_{(0.01)}$												
NVITAL	0.13 $_{(0.06)}$	-0.11 $_{(0.06)}$		0.09 $_{(0.79)}$	-0.86 $_{(0.38)}$	0.25 $_{(0.46)}$	0.19 $_{(0.56)}$	0.38 $_{(0.40)}$	-0.87 $_{(0.81)}$	-0.50 $_{(0.86)}$	-0.83 $_{(0.27)}$	-0.14 $_{(0.33)}$	
	0.18 $_{(0.03)}$	-0.16 $_{(0.03)}$											
NPALE	-0.07 $_{(0.06)}$	0.02 $_{(0.06)}$	-0.23 $_{(0.05)}$		-0.43 $_{(1.15)}$	-0.14 $_{(0.67)}$	-0.90 $_{(1.02)}$	-0.28 $_{(0.58)}$	-0.87 $_{(0.81)}$	-0.43 $_{(0.96)}$	0.66 $_{(0.75)}$	0.25 $_{(0.49)}$	
	-0.07 $_{(0.03)}$	0.04 $_{(0.03)}$	-0.21 $_{(0.03)}$										
NTHIN	-0.13 $_{(0.06)}$	0.12 $_{(0.06)}$	-0.45 $_{(0.05)}$	0.32 $_{(0.05)}$		-0.61 $_{(0.57)}$	0.05 $_{(0.60)}$	-0.22 $_{(0.42)}$	-0.76 $_{(0.67)}$	-0.06 $_{(0.75)}$	0.68 $_{(0.45)}$	0.10 $_{(0.38)}$	
	-0.15 $_{(0.03)}$	0.14 $_{(0.03)}$	-0.48 $_{(0.02)}$	0.28 $_{(0.03)}$									
RESP2	-0.07 $_{(0.07)}$	0.03 $_{(0.07)}$	0.08 $_{(0.07)}$	0.01 $_{(0.06)}$	0.04 $_{(0.07)}$		1.0 $_{(0.49)}$	0.09 $_{(0.33)}$	0.39 $_{(0.41)}$	0.32 $_{(0.59)}$	0.37 $_{(0.31)}$	0.03 $_{(0.29)}$	
	0.09 $_{(0.03)}$	-0.04 $_{(0.03)}$	0.10 $_{(0.03)}$	-0.01 $_{(0.03)}$	-0.03 $_{(0.03)}$								
RESP5	-0.01 $_{(0.07)}$	-0.04 $_{(0.06)}$	0.08 $_{(0.06)}$	0.08 $_{(0.06)}$	-0.04 $_{(0.06)}$	0.03 $_{(0.07)}$		-0.13 $_{(0.41)}$	-0.27 $_{(0.56)}$	0.36 $_{(0.63)}$	0.72 $_{(0.39)}$	0.64 $_{(0.34)}$	
	-0.01 $_{(0.03)}$	0.04 $_{(0.03)}$	0.09 $_{(0.03)}$	0.02 $_{(0.03)}$	0.03 $_{(0.03)}$	0.14 $_{(0.03)}$							
RECT2	-0.16 $_{(0.08)}$	0.16 $_{(0.07)}$	-0.07 $_{(0.07)}$	0.03 $_{(0.06)}$	0.02 $_{(0.07)}$	0.17 $_{(0.07)}$	0.10 $_{(0.07)}$		0.76 $_{(0.29)}$	0.39 $_{(0.52)}$	0.42 $_{(0.29)}$	0.30 $_{(0.23)}$	
	0.02 $_{(0.03)}$	0.00 $_{(0.03)}$	0.00 $_{(0.03)}$	0.00 $_{(0.03)}$	-0.01 $_{(0.03)}$	0.15 $_{(0.03)}$	0.07 $_{(0.03)}$						
RECT5	-0.06 $_{(0.07)}$	0.06 $_{(0.06)}$	-0.06 $_{(0.06)}$	0.06 $_{(0.06)}$	0.05 $_{(0.06)}$	-0.02 $_{(0.07)}$	0.38 $_{(0.06)}$	0.24 $_{(0.06)}$		0.73 $_{(0.77)}$	-0.26 $_{(0.34)}$	0.31 $_{(0.30)}$	
	0.03 $_{(0.03)}$	0.01 $_{(0.03)}$	0.03 $_{(0.03)}$	-0.02 $_{(0.03)}$	-0.02 $_{(0.03)}$	0.04 $_{(0.03)}$	0.31 $_{(0.03)}$	0.32 $_{(0.03)}$					
MAST2	-0.06 $_{(0.06)}$	0.06 $_{(0.06)}$	-0.01 $_{(0.06)}$	-0.03 $_{(0.05)}$	-0.03 $_{(0.06)}$	0.01 $_{(0.06)}$	0.08 $_{(0.06)}$	0.04 $_{(0.06)}$	-0.08 $_{(0.06)}$		-0.08 $_{(0.52)}$	-0.07 $_{(0.45)}$	
	-0.09 $_{(0.03)}$	0.12 $_{(0.03)}$	-0.04 $_{(0.03)}$	-0.04 $_{(0.03)}$	-0.03 $_{(0.03)}$	0.04 $_{(0.03)}$	0.10 $_{(0.03)}$	0.08 $_{(0.03)}$	-0.02 $_{(0.03)}$				
TEATU2	-0.08 $_{(0.08)}$	0.07 $_{(0.07)}$	0.07 $_{(0.08)}$	-0.16 $_{(0.06)}$	-0.14 $_{(0.07)}$	-0.16 $_{(0.08)}$	-0.04 $_{(0.07)}$	-0.13 $_{(0.08)}$	0.02 $_{(0.07)}$	0.06 $_{(0.07)}$		0.55 $_{(0.19)}$	
	-0.07 $_{(0.03)}$	0.07 $_{(0.03)}$	-0.11 $_{(0.03)}$	-0.08 $_{(0.03)}$	-0.01 $_{(0.03)}$	-0.05 $_{(0.03)}$	0.08 $_{(0.03)}$	0.00 $_{(0.03)}$	-0.03 $_{(0.03)}$	0.04 $_{(0.03)}$			
TEATF2	-0.02 $_{(0.08)}$	0.02 $_{(0.08)}$	-0.01 $_{(0.08)}$	-0.07 $_{(0.07)}$	-0.18 $_{(0.08)}$	-0.17 $_{(0.08)}$	-0.13 $_{(0.08)}$	-0.07 $_{(0.09)}$	-0.03 $_{(0.08)}$	-0.03 $_{(0.07)}$	0.20 $_{(0.08)}$		
	0.08 $_{(0.03)}$	-0.05 $_{(0.03)}$	-0.03 $_{(0.03)}$	-0.02 $_{(0.03)}$	-0.04 $_{(0.03)}$	-0.12 $_{(0.03)}$	0.03 $_{(0.03)}$	0.04 $_{(0.03)}$	0.05 $_{(0.03)}$	-0.03 $_{(0.03)}$	0.30 $_{(0.03)}$		
FRAF	-0.09 $_{(0.06)}$	0.10 $_{(0.06)}$	0.09 $_{(0.06)}$	0.03 $_{(0.05)}$	0.00 $_{(0.06)}$	-0.06 $_{(0.06)}$	-0.07 $_{(0.06)}$	0.08 $_{(0.06)}$	0.02 $_{(0.06)}$	-0.04 $_{(0.06)}$	-0.08 $_{(0.07)}$	-0.07 $_{(0.08)}$	
	-0.07 $_{(0.03)}$	0.06 $_{(0.03)}$	0.10 $_{(0.03)}$	0.04 $_{(0.03)}$	0.01 $_{(0.03)}$	-0.05 $_{(0.03)}$	-0.05 $_{(0.03)}$	0.09 $_{(0.03)}$	0.00 $_{(0.03)}$	0.02 $_{(0.03)}$	-0.04 $_{(0.03)}$	0.07 $_{(0.03)}$	

For trait name abbreviations see Table 1; * standard errors >1.00